Title of the Invention

Multifocal Lens System for Digital Cameras

Background of the Invention

1. Field of the Invention

The present invention relates to an optical system that has a plurality of lenses of two different focal lengths in a digital camera (hereinafter referred to as DSC), and by using a parallelogram prism (rhombic prism) or a pair of triangular prisms those two lenses can be placed in the image capturing position interchangeably.

2. Background Art

To obtain different focal lengths in a camera, usually zoom lenses, multifocal lens turrets and conversion lenses have been commonly used. The zoom lenses are relatively expensive and constructions are complicated and difficult to be made. The lens turret system is much easier than zoom lenses in manufacturing, however, longer focal lenses are always protruded and cannot be retracted in to the camera body, and that makes the camera bulky. There are two kinds of conversion lens. One is to be attached to the front of camera lens, of which the focal magnification is very limited due to its size, and it is extremely difficult to obtain a focal magnification of two times. This type of front conversion lenses is too bulky for a DSC, because usually the sizes of DSC lenses are much smaller than analogue camera lenses, and when used in a DSC, the durability of the total lens with a front conversion lens will be in question. The other is a behind lens

type conversion (a rear conversion lens), which is to be inserted behind the master lens to change the focal length of the master lens, but also the ratio of focal magnification is limited, and further more the mechanism to insert the rear conversion lens behind the very small sized DSC master lens is very complicated and not easy to be designed and manufactured.

Fig. 1 shows a typical design of lens turret system, of which telephoto lens is protruded from the camera, and Fig. 2 shows an example of a front conversion lens to be attached to a camera, which inevitably becomes quite large.

It is therefore an object of this invention to provide a multifocal lens system which is much less expensive and easier in manufacturing than zoom lenses, and not so bulky as lens turret systems and front conversion lenses, and not so complicated in mechanism as rear conversion lenses, and yet which can easily obtain large magnification like 3 times or over.

Summary of the Invention

A primary object of the present invention is to provide a multifocal lens system for digital cameras comprising a wide-angle lens, a telephoto lens, a parallelogram prism or a pair of triangular prism, and a certain mechanism with which the prism or the prisms can be moved sliding from side to side. The wide-angle lens is placed in front of an image sensor such as CCD or C-MOS aligning its optical axis with the center of the image sensor. The telephoto lens is placed alongside the wide-angle lens. A parallelogram prism or a pair ~~of~~ triangular prisms is placed movably at the rear of those two lenses. When the wide-angle lens is to be used, the parallelogram prism or one of the two

triangular prisms is positioned not to cover any part of the sensor, and stay only at the rear of the telephoto lens, so that the wide-angle lens can be focused on the sensor to capture an image. When the telephoto lens is to be used, the parallelogram prism or one of the two triangular prisms moves onto the image sensor to cover its sensing area enabling light from the object to pass therethrough and shutting light through the wide-angle lens, so that the telephoto lens can be focused on the sensor to capture an image.

Thus the multifocal lens system according to the present invention is so designed as to be capable of changing focal length instantly by moving only the parallelogram prism or the two triangular prisms at the rear of the wide-angle and telephoto lenses from side to side. It is not necessary for the multifocal lens system according to the present invention to rotate both of the wide-angle and telephoto lenses using a turret mechanism that is bulky and occupies much more space, also it is not necessary to attach a bulky conversion lens onto the master lens, and further it is not necessary to insert any auxiliary lenses behind the master lens to change the focal length of the lens system, which is rather complicated in mechanism and yet not capable enough to change the focal length magnification effectively.

Moreover the multifocal lens system according to the present invention uses the telephoto lens of which the light path is reflected through the parallelogram prism or reflected on the mirror surfaces of the two triangular prisms, and consequently the distance between the wide-angle lens and the focal plane of the sensor and the physical distance between the telephoto and the focal plane of sensor could be almost the same, and the telephoto lens can be placed at the same level as the wide-angle lens preventing the telephoto lens from protruding much

higher than the level of wide-angle lens.

Brief Description of the Drawings

Fig. 1 is a perspective view of a conventional lens turret system;

Fig. 2 is a perspective view of a front conversion lens system;

Fig. 3 is an exploded perspective view of the first embodiment of the multifocal lens system according to the present invention;

Fig. 4 is a partly cross-sectional view of the multifocal lens system of the first embodiment according to the present invention to show the status that the telephoto lens is in use;

Fig. 5 is a partly cross-sectional view of the multifocal lens system of the first embodiment according to the present invention to show the status that the wide-angle lens is in use;

Fig. 6 is an exploded perspective view of the second embodiment of the multifocal lens system according to the present invention;

Fig. 7 is a partly cross-sectional view of the multifocal lens system of the second embodiment according to the present invention to show the status that the telephoto lens is in use; and

Fig. 8 is a partly cross-sectional view of the multifocal lens system of the second embodiment according to the present invention to show the status that the wide-angle lens is in use.

Detailed Description of the Invention

Figures 3, 4 & 5 show a preferable embodiment of the present invention, namely the multifocal lens system for digital cameras, which comprises a wide-angle lens (1), a telephoto lens (2), a parallelogram prism (a rhombic shaped prism) (3), a shutter blade (4) attached on said prism, a housing (5), a lens holder (6) and a prism holder (7). The wide-angle lens (1) and the telephoto lens (2) are positioned side by side on top of the lens holder (6) as shown by Fig. 4 & 5. Inside the housing (5), there is the parallelogram prism (3), which is held by the prism holder (7). The prism holder (7) is movable from side to side at the rear of the wide-angle (1) and telephoto (2) lenses sliding inside the housing (5), and the prism holder (7) can be operated by a knob (8) from side to side from the outside of the housing (5). On the prism holder (7) the shutter blade (4) is provided, and when the wide-angle lens (1) is in use as shown by Fig. 5, the shutter blade (4) and the parallelogram prism (3) are removed from the rear of the wide-angle lens (1) so that the light that comes through the wide-angle lens (1) can reach the image sensor (9) that is placed underneath the wide-angle lens (1) and form an image of object on the focal plane of the image sensor (9). When the wide-angle lens (1) is in use, the parallelogram prism (3) and the prism holder (7) shut off the light that comes through the telephoto lens (2) and the light is unable to reach the image sensor (9). When the telephoto lens (2) is in use as shown by Fig. 4, the parallelogram prism (3) is moved to the rear of the wide-angle lens (1), and the shutter blade (4) shuts off the light coming through the wide-angle lens (1) having the light be unable to reach the image sensor (9). The parallelogram prism (3) has two inclined surfaces (10), and the outer side of inclined surfaces (10) are coated by aluminum metalizing, or that sort of vacuum

deposition so that the inner sides of those coated inclined surfaces (10) can work as mirrors, namely mirror (11) and mirror (12). The position of the telephoto lens (2) is so designed as to enable the light coming through the telephoto lens (2) to be reflected by the mirrors (11 & 12) of the parallelogram prism (3) and to reach the image sensor (9) to form an image of object properly on the sensor focal plane.

As described so far, when the parallelogram prism (3) is removed from the rear of the wide-angle lens (1), the wide-angle lens (1) can be used to capture images shutting the light coming through the telephoto lens (2) as shown by Fig. 5, and when the parallelogram prism (3) is moved to the rear of the wide-angle lens (1), the light coming through the wide-angle lens (1) is shut by the shutter blade (4) and does not reach the image sensor (9), meanwhile the light coming through the telephoto lens (2) goes through the parallelogram prism (3) being reflected by the two mirrors (11 & 12) of the inclined surfaces (10) of the parallelogram prism (3) and reaches the image sensor to form an image there, and the telephoto lens (2) can be used as shown by Fig. 4.

Thus this multifocal lens system according to the present invention can set one of these two lenses, namely the wide-angle lens (1) and the telephoto lens (2) in an image capturing position by simply and easily switching the position of the parallelogram prism (3).

Further more, by using the two mirrors (11 & 12) of the parallelogram prism (3), the light path of the telephoto lens (2) can be bent twice, and consequently the distance between the telephoto lens (2) and the image sensor (9) can be adjusted same as the distance between the wide-angle lens (1) and the image sensor (9).

As the result of this distance adjustment, the wide-angle lens (1) and the telephoto lens (2) can be placed at the same level on the lens holder (6) so that the total size of the multifocal lens system of the present invention can be much more compact in comparison with other systems like lens-turret mechanism or conversion lens systems.

Figures 6, 7 & 8 show another preferable embodiment of the present invention, namely the multifocal lens system for digital cameras, which comprises a wide-angle lens (1), a telephoto lens (2), two triangular prisms (right angle prisms) (13 & 14), a shutter blade (4), a housing (5), a lens holder (6) and a prism holder (7). The wide-angle lens (1) and the telephoto lens (2) are positioned side by side on top of the lens holder (6) as shown by Fig. 7 & 8. Inside the housing (5), there are the triangular prisms (13 & 14), which are held by the prism holder (7). The prism holder (7) is movable from side to side at the rear of the wide-angle (1) and telephoto (2) lenses sliding inside the housing (5), and the prism holder (7) can be operated by a knob (8) from side to side from the outside of the housing (5). On the prism holder (7) the shutter blade (4) is provided, and when the wide-angle lens (1) is in use, the shutter blade (4) and the prism holder (7) are removed from the rear of the wide-angle lens (1) so that the light that comes through the wide-angle lens (1) can reach the image sensor (9) and form an image of object on the focal plane of the image sensor (9). When the wide-angle lens (1) is in use, the triangular prisms (13 & 14) and the prism holder (7) shut off the light that comes through the telephoto lens (2) and the light is unable to reach the image sensor (9). When the telephoto lens (2) is in use as shown by Fig. 7, one of the triangular prisms (14) is moved to the rear of the wide-angle lens (1), and the shutter blade (4) shuts off the light coming

through the wide-angle lens (1) having the light be unable to reach the image sensor (9). Each of the triangular prisms (13 & 14) has an inclined surface (15 and 16), and the outer side of the surfaces (15 & 16) of the triangular prisms are coated by aluminum metalizing, or that sort of vacuum deposition so that the outer sides of those coated inclined surfaces (15 & 16) can work as mirrors, namely mirror (17) and mirror (18). The position of the telephoto lens (2) is so designed as to enable the light coming through the telephoto lens (2) to be reflected by the mirrors (17 & 18) of the triangular prisms (13 & 14) and to reach the image sensor to form an image of object properly on the sensor focal plane.

As described so far, when the triangular prisms (13 & 14) are removed from the rear of the wide-angle lens (1), the wide-angle lens can be used to capture images shutting the light coming through the telephoto lens (2), and when the triangular prism (14) is moved to the rear of the wide-angle lens (1), the light coming through the wide-angle lens (1) is shut by the shutter blade (4) and does not reach the image sensor (9), meanwhile the light coming through the telephoto lens (2) goes along the triangular prisms (13 & 14) being reflected by the two mirrors (17 & 18) of the inclined surfaces (15 & 16) of the triangular prisms (13 & 14) and reaches the image sensor (9) to form an image there, and the telephoto lens (2) can be used.

Thus this multifocal lens system according to the present invention can set one of these two lenses, namely the wide-angle lens (1) and the telephoto lens (2) in an image capturing position by simply and easily switching the position of the triangular prisms (13 & 14).

Further more, by using the two mirrors (17 & 18) of the triangular prisms (13 &

14), the light path of the telephoto lens (2) can be bent twice, and consequently the distance between the telephoto lens (2) and the image sensor (9) can be adjusted same as the distance between the wide-angle lens (1) and the image sensor (9). As the result of this distance adjustment, the wide-angle lens (1) and the telephoto lens (2) can be placed at the same level on the lens holder (6) so that the total size of the multifocal lens system of the present invention can be much more compact in comparison with other systems like lens-turret mechanism or conversion lens systems.

List of Reference Numerals

Fig. 3

1. Wide-angle lens
2. Telephoto lens
3. Parallelogram prism
4. Shutter blade
5. Housing
6. Lens holder
7. Prism holder
8. Knob
9. Image sensor

Fig. 4

1. Wide-angle lens
2. Telephoto lens
3. Parallelogram prism
4. Shutter blade
5. Housing
6. Lens holder
9. Image sensor
10. Inclined surfaces
11. Mirror
12. Mirror

Fig. 5

1. Wide-angle lens
2. Telephoto lens
3. Parallelogram prism
4. Shutter blade
5. Housing
6. Lens holder
9. Image sensor
10. Inclined surfaces
11. Mirror
12. Mirror

Fig. 6

1. Wide-angle lens
2. Telephoto lens
4. Shutter blade
5. Housing
6. Lens holder
7. Prism holder
8. Knob
9. Image sensor
13. Triangular prism
14. Triangular prism

Fig. 7

1. Wide-angle lens

2. Telephoto lens
4. Shutter blade
5. Housing
6. Lens holder
9. Image sensor
13. Triangular prism
14. Triangular prism
15. Inclined surface
16. Inclined surface
17. Mirror
18. Mirror

Fig. 8

1. Wide-angle lens
2. Telephoto lens
4. Shutter blade
5. Housing
6. Lens holder
9. Image sensor
13. Triangular prism
14. Triangular prism
15. Inclined surface
16. Inclined surface
17. Mirror
18. Mirror